

SCIENTIFIC LETTERS

Regional myocardial wall thickening assessed at rest by ECG gated ^{18}F -FDG positron emission tomography and by magnetic resonance imaging

Positron emission tomography (PET) studies of the heart focus on evaluation of myocardial blood flow and metabolism.¹ These measurements must frequently be correlated with changes in left ventricular (LV) contraction to delineate myocardial viability fully.² Usually, this requires assessment of myocardial contraction using a different imaging modality; however, this information may be obtained at a different time and in different planes from the PET studies. In segments displaying impaired contraction, the preservation of glucose metabolism is a marker of jeopardised but viable myocardium in patients with coronary artery disease.

We describe a pilot study using ECG gated PET with ^{18}F -fluorodeoxyglucose (FDG) to detect segments with reduced wall thickening. Wall thickening is compared to ECG gated cine-magnetic resonance imaging (MRI). MRI is well validated for the assessment of myocardial motion and thickening in patients with normal and impaired LV contraction.³

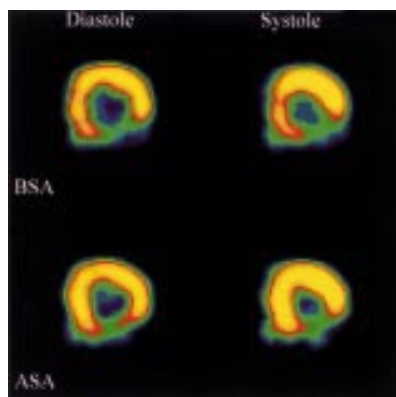
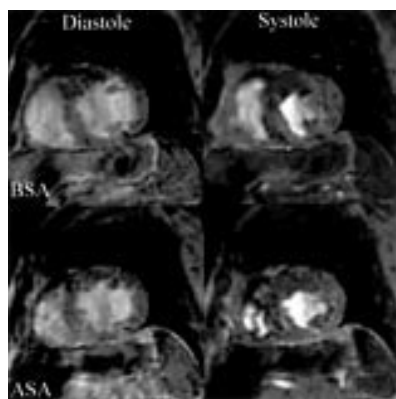


Figure 1 (Top) Representative diastolic and systolic frames from a cine-MRI sequence with (below) the corresponding ECG gated ^{18}F -FDG tomograms. BSA, basal short axis; ASA, atypical short axis.

The study population comprised nine patients (all men) with ischaemic heart disease and LV impairment, from angiography. Their mean age was 62 years (range 42–75 years).

Cine-MR images were obtained in the short axis, positioned using the end systolic long axis view as the frame of reference. Acquisitions were synchronised to the ECG, using the R wave as a trigger. Seven cardiac phases were obtained with a frame separation of 80 ms. Four non-contiguous slices were imaged to cover the length of the left ventricle.

PET imaging was performed using a Siemens ECAT 31 PET scanner within one week of MR imaging. Attenuation correction was achieved by performing a transmission scan before the emission scan. ^{18}F -FDG (4–5 mCi) was injected intravenously one hour after a 50 g dose of oral glucose. The ^{18}F -FDG emission scan, acquired 60 minutes postinjection, was gathered in ECG gated mode using the R wave. Multiple phase FDG images were produced by reforming the axial views of the left ventricle into four short axis sections using visual comparison of the long axis views of both imaging techniques, with a reconstructed and reorientated resolution of 8 mm.

Four short axis planes from MR and PET were alternatively reviewed in separate random orders in a continuous loop cine format by two observers, independently and without knowledge of the clinical data. Each of the short axis slices was divided into four segments (anterior, lateral, inferior, and septal, according to conventional anatomic landmarks). Wall thickening was graded using a three point scale (0 = absent or severely impaired wall thickening; 1 = segments with better thickening, 2 = cannot be judged). PET scoring was based on the changes in regional counts and endocardial wall position through the cardiac cycle.

For interobserver variation, scores by the two observers were compared. For intraobserver variation, the MR and PET images were assessed on a second occasion by one of the observer.

The sensitivity and specificity of gated FDG, compared to the gold standard of gated MRI, to determine myocardial wall thickening was determined using standard formulae. Intraobserver and interobserver variability were evaluated by Cohen's κ statistic.

All patients underwent both studies without complication and eight had good quality images that were judged to be evaluable by the observers (fig 1). One PET examination resulted in data that were uninterpretable, and that patient was therefore removed from the study.

Abnormal wall thickening was present in all patients, with 49 abnormal segments, 75 normal segments, and four that could not be scored. Intraobserver and interobserver reproducibility of the MR studies was 85% ($\kappa = 0.67$) and 83% ($\kappa = 0.65$), respectively.

Abnormal wall thickening was present in all patients, with 48 abnormal segments, 71 normal segments, and nine that could not be scored. Intraobserver and interobserver reproducibility of the PET studies was 95% ($\kappa = 0.88$) and 70% ($\kappa = 0.37$), respectively. Of the nine segments that could not be scored because of reduced tracer uptake, seven (78%) were found to have abnormal wall thickening and two (22%) normal wall thickening from MRI.

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Of 128 segments, 13 (10%) were deemed uninterpretable because of either inadequate tracer uptake in PET or inadequate blood myocardium contrast in MR. Thus 115 segments were available for comparison (table 1). Gated ^{18}F -FDG PET and MRI showed a correlation in 93/115 (81%) segments. Taking MRI as the gold standard for the assessment of wall thickening gated ^{18}F -FDG PET was found to have a sensitivity of 79% and a specificity of 82% for the detection of segments with severely reduced or absent wall thickening.

Intraobserver agreement for both modalities was 219/252 segments (87%, $\kappa = 0.73$).

Table 1 Comparison of determination of reduced wall thickening by MRI and ECG gated ^{18}F -FDG

PET imaging score	MRI score	
	0	1
0	33	13
1	9	60

Interobserver agreement was 207/270 segments (77%, $\kappa = 0.53$).

PET is a highly developed tool for the study of myocardial perfusion and metabolism. In contrast to the research with flow and metabolism, little effort has been devoted to the assessment of myocardial contraction by PET. Measurement of myocardial contractility has usually been performed by echocardiography, radionuclide ventriculography or MRI. The use of different imaging modalities increases the complexity of the studies and may be affected by time differences while also requiring the accurate registration of anatomic segments from images acquired in different planes. We have validated gated ^{18}F -FDG PET for visual assessment of regional LV function at rest, against the accepted gold standard of cardiac MRI

which is known to provide reliable estimates of both endocardial motion and myocardial wall thickening. PET wall thickening was judged from changes in regional counts and changes in endocardial wall position through the cardiac cycle. The combination of an increase in regional counts and change in apparent endocardial wall position has been shown to provide a method of estimating wall thickening that compensates for the partial volume effects.⁴ There was good overall agreement between the two methods, allowing accurate assessment of myocardial contraction in regions that are spatially equivalent to studies of metabolism.

We have assessed regional ventricular function at rest using ECG-gated ^{18}F -FDG PET. Two observers easily interpreted most of the images and there was good intra- and interobserver agreement. Patients investigated with coronary artery disease showed there was good overall agreement with MRI for segmental wall thickening. This will facilitate the integration of the assessment of myocardial metabolism and mechanical function by PET.

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IMAGES IN CARDIOLOGY



Biventricular diverticula in a patient with restrictive cardiomyopathy

The simultaneous occurrence of both right and left ventricular diverticula is extremely rare and usually associated with midline thoracic congenital defects. The association of biventricular diverticula with restrictive cardiomyopathy, however, has not been described so far.

A 16 year old male underwent evaluation for heart transplantation because of progressive dyspnoea, dizziness, and palpitations caused by restrictive cardiomyopathy of unknown aetiology which was unresponsive to conventional medical treatment. Idiopathic restrictive cardiomyopathy had been diagnosed at the age of less than 1 year and was associated with growth retardation, but no other overt congenital defects. During childhood and early adolescence the boy remained limited in his physical performance compared to his schoolmates. Since the autumn of 1997 progressive deterioration with dyspnoea and symptomatic arrhythmia such as atrial re-entry tachycardia or atrial flutter occurred and made further attendance of school almost impossible. Medi-

cal treatment was ineffective and, after clinical reassessment, the patient was put on the waiting list for heart transplantation in early 1998.

Echocardiographic examination at this time revealed the presence of biventricular diverticula located beneath the subtricuspid lateral right ventricular wall and submitral lateral left ventricular wall, respectively (LV, left ventricle; RV, right ventricle, IVC, inferior vena cava). Restrictive cardiomyopathy with massive enlargement of both atria, an increase in left ventricular wall thickness, and a reduced ejection fraction of 40% was confirmed.

The patient underwent successful heart transplantation in the summer of 1999. Pathologic anatomic examination of the explanted heart confirmed the diagnosis of idiopathic restrictive cardiomyopathy, and also the presence of a right and left ventricular basal subanular diverticula (arrows).

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